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ON COARSE GABBROID DIABASE IN WESTFIELD, MASSACHUSETTS¹

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In the western part of the town of Westfield, Massachusetts, a number of quarries have been opened in the Holyoke diabase sheet. These quarries are the same which have furnished the beautiful datolite specimens which are to be found in all collections. The diabase or trap in which these quarries are located is the middle or main extrusive trap sheet of the Connecticut Valley Triassic area. Here the main portion of the sheet is composed of a gray holocrystalline diabase of fine to medium grain not unlike the intrusive traps which form East and West Rocks near New Haven. In the northernmost of the four quarries there occur, included in the normal rock, irregular areas of a gabbroid rock very unusual in appearance for an extrusive lava. While studying the occurrence of datolite and other secondary minerals in these quarries, the writer's attention was attracted to these very coarse-grained phases of the sheet and they were examined in some detail. At first it was believed that they represented a later intrusion which had chanced to penetrate the previously existing flow, but a study of the relations of the coarse material to the surrounding diabase of normal grain led to the abandonment of this view. The contact with the surrounding rock is sharp, the transition from coarse to fine material being accomplished in a distance of an inch or less. The coarse-grained gabbro forms irregular rounded areas often many yards in diameter in the finer-grained diabase. In the hand specimen this coarse rock shows broad blades of bronzy greenish-black pyroxene which reach an inch or more in length, imbedded in a coarse granular aggregate of pyroxene and greenish feldspar. Under the microscope the rock is seen to be composed of large

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crystals of pyroxene and plagioclase in a subordinate fine-grained ground-mass composed largely of needle-like crystals of plagioclase with interstitial augite in anhedral patches now largely altered to a greenish-brown chlorite which is probably diabantite.¹ The large pyroxene phenocrysts are rather pale greenish-brown in color, with well-developed cleavage. They are unaltered and are in part transparent and in part turbid from the presence of an opaque brownish pigment. They are not commonly simple but are bladed aggregates made up of a number of irregular interlocking crystals not quite in parallel position so that they do not all extinguish simultaneously. In composition this pyroxene is ordinary augite. The plagioclase phenocrysts are characterized by rather narrow twinning lamellae and are near-basic andesine in composition. The most striking microscopic feature of the rock is the presence of broad patches of a graphic intergrowth of plagioclase and augite in fixed orientation, giving remarkable pegmatitic textures entirely analogous to the quartz-feldspar aggregates of graphic granite. In places a phenocryst of plagioclase terminates in a branching fernlike intergrowth of plagioclase and augite.

A question naturally arises as to the origin of such coarse forms in an intrusive flow less than a hundred feet in thickness. Ordinarily such surface flows cool too rapidly to permit the growth of large crystal individuals. The mode of occurrence of this coarse phase indicates that the large crystals of plagioclase and augite were formed after the lava had reached its present position and precludes the supposition that it was intruded into the extrusive sheet after the sheet had been buried by later sedimentation. Emerson² has described similar coarse forms from this trap sheet further north associated with mudstone, pitchstone, etc., formed by the molten lava coming in contact with water and mud. Strangely enough, he attributes the coarseness of grain of the plumose diabase to sudden cooling or quenching of the molten

¹ Earl V. Shannon, "Diabantite, Stilpnomelane, and Chalcodite from Westfield, Massachusetts," *Proc. U.S. Nat. Mus.* In print.

² B. K. Emerson, "Plumose Diabase and Palognite from the Holyoke Trap Sheet," *Bull. Geol. Soc. Amer.*, XVI (1905), 91.

material by the water. This is quite contrary to our knowledge of the effect of the rate of cooling upon the grain of igneous rocks. The writer after some study has reached the conclusion that the coarseness of crystallization of the gabbroid diabase is due to absorption of confined water by the still molten portion of the flow, with the formation of miniature pegmatite chambers. Quite certainly here as elsewhere the lava of this flow encountered moist mud flats and ponds of water. The coarse gabbro occurs for the most part near but not at the top of the flow. If we may conceive the top of the flow as forming here a resistant crust due to early solidification, the water from below heated to a high temperature and ascending through the still molten lava must come to rest beneath the previously solidified crust and might readily be conceived to mix with the still molten material to form a magma rich in volatile constituents and thus capable of remaining fluid for longer periods and at lower temperatures than when in its original dry state. This would permit the formation of coarse-grained pegmatitic textures like those here described. Emerson has shown in the paper cited that water did ascend through the flow and that such water in some instances caused explosions rupturing the upper crust. It is easy to understand how pressures could obtain in a pegmatitic chamber of the sort indicated sufficient to rupture the roof of solid diabase after the formation of large plumose crystals of augite was well advanced. The remaining molten material would be chilled following the explosion and yield perlitic glasses associated with plumose diabases exactly in the manner described by Emerson.